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ABSTRACT

Since the 1960s, gender differences in mathematics performance have been a major topic in educational and mathematical research. This study entails a gender comparative analysis of students' mathematics performance as determined by the Iowa Test of Basic Skills and by the Tests of Achievement and Proficiency. In a public school system in rural Southwest Georgia, 1,172 students enrolled in Grades 1 through 10 took these tests. An analysis of variance found a significant difference in the total mathematics achievement scores between genders [$F(1, 1171)=13.222$, $p<.001$] in favor of the female students. Additional analyses of variance revealed statistically significant differences in mathematics performance favoring females over males in the first grade [$F(1, 115)=8.785$, $p<.005$] and in the 4th grade [$F(1, 99)=11.821$, $p<0.002$]. In all grades, except the second grade, the females' scores were higher than the males'. Explanations for this outcome are attributed to social issues including ethnic background, socio-economic status, and teacher-student relationships. Ethnic background and socio-economic status account for gender differences in achievement favoring females, and expectations and visible role models presented by the teachers could also affect performance in the students favoring females. When accounting for the social situations of this population, the findings are commensurate with previous studies done on this type of population. Contains 14 references. (Author)

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**RUNNING HEAD: Gender Differences**

# Gender Differences in Mathematics Performance

by

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**Abstract**

Since the 1960s, gender differences in mathematics performance have been a major topic in educational and mathematical research. This study entails a gender comparative analysis of students' mathematics performance as determined by the Iowa Test of Basic Skills and by the Tests of Achievement and Proficiency. In a public school system in rural Southwest Georgia, 1,172 students enrolled in Grades 1 through 10 took these tests. An analysis of variance found a significant difference in the total mathematics achievement scores between genders [$F(1, 1171)=13.222$, $p<.001$] in favor of the female students. Additional analyses of variance revealed statistically significant differences in mathematics performance favoring females over males in the 1st grade [$F(1, 115)=8.785$, $p<.005$] and in the 4th grade [$F(1, 99)=11.821$, $p<0.002$]. In all grades, except the second grade, the females' scores were higher than the males'. Explanations for this outcome are attributed to social issues including ethnic background, socio-economic status, and teacher-student relationships. Ethnic background and socio-economic status account for gender differences in achievement favoring females, and expectations and visible role models presented by the teachers could also affect performance in the students favoring females. When accounting for the social situations of this population, the findings are commensurate with previous studies done on this type of population.

## INTRODUCTION

The ability of any nation to compete successfully in a global market today depends on the mathematical literacy of its citizens. In the United States, this literacy has been called into question by the poor showing of United States' students in Mathematics assessments in both national and international studies (Clewell, Anderson, & Thorpe, 1992). Recently, there has been a rising concern about the human resource needs of the United States to compete in a global market that relies heavily on technological innovation. There has been a decline in the pool of people equipped to assume mathematics positions in industry and education. The underrepresentation of women in mathematics poses a problem of national scope. The causes of this underrepresentation of women in mathematics are varied and complex. Research into these causes has revealed that females and minorities face similar barriers to participation in these fields:

> (1) negative attitudes regarding mathematics and science; (2) lower performance levels than those of White males in mathematics and science courses and on standardized tests of these subjects; (3) limited exposure to extracurricular mathematics and science activities and failure to participate in advanced mathematics and science courses in high school; and (4) lack of information about and/or interest in mathematics- or science-related careers. (Clewell, Anderson, & Thorpe, 1992, p. 5)

For the United states to maintain a distinguished position in the world economy, the mathematical skills of its populace must be elevated. A coinciding goal should be bringing into

parity in math achievement the fastest-growing segment of the population (one that has traditionally underachieved in the area of mathematics). Women, who make up roughly half of the population, are vastly considered underachievers in the area mathematic.

It is important that research continue on the effects of gender in the learning ability of mathematics. Society must take responsibility to resolve this issue so that the market for high achieving mathematics students will not be exhausted.

**REVIEW OF LITERATURE**

In the United States of America, there has been a noted decline of women in the field of mathematics (Clewell, Anderson, & Thorpe, 1992). Is this decline biological, sociological, or perhaps the results of the educational system in America? Data from the Nation Science Foundation (1990) show that in 1988 a disproportionately small number of women (16%) held positions in mathematical related fields (Clewell, Anderson, & Thorpe, 1992). This problem of under-representation of females in these areas is a problem for everybody. The failure to recruit under-represented women is undermining the nation's ability to maintain its leadership in mathematical related fields. Each year in the United States of America, research is developed on the issue of gender and its affect on the learning ability of mathematics. Mathematics is becoming more and more important in all areas of work and education. Over the past 20 years, there has been a decline in the gender gap in the field of mathematics (Meece & Jones, 1996). However, it is noted that there are still significant differences between the genders by the end of high school (Meece & Jones, 1996). Since there has been a noticeable gap, many researchers have asked "Why?" These researchers have completed many coinciding and conflicting results. They have reported innate differences in mathematics ability between males and females,

differential coursework, the number of mathematics courses one has taken, the role played by parents, teachers, and peers, and a student's attribution of success and failure in the domain (Ramos & Lambating, 1996). These factors have been taken into deep consideration in order to understand the reason that differences occur and hopefully close or further narrow the gender gap.

It is, however, important that research continue on the effects of gender in the learning ability of mathematics. Society must take responsibility to resolve this issue so that the market for high achieving mathematics students will not be exhausted in the years to come.

For over 30 years, indepth research has been done on the effects of gender on the learning ability of the mathematics. Although gender differences are reported to appear in all subjects, research suggests that gender differences are especially pronounced in mathematics classes at the secondary level (Skaalvik & Rankin, 1994). Much of the research findings support the same viewpoint. Reviewing research prior to the 1970s concluded that gender differences favoring boys in mathematics ability were well established. Data collected in the 1960s show that is no gender differences in mathematics achievement in the fifth grade. This research has also shown that by the end of high school boys perform better than girls on mathematics achievement tests (Skaalvik & Rankin, 1994). This review of the literature will take on four subordinate areas: biological/genetic, heredity, elementary through middle grade years, and finally, high school years.

Begley (1996) supports that mathematical and logical skills are developed from the ages of birth to four years old. This is irrelevant to the sex or race. It is further stated that circuits for mathematical skills reside in the brain's cortex, near those for music. Research has been noted to

report that males' brains and females' brain are different in structure. Beckwith (1983) reports that women would never reach the intellectual heights of men, since their brains were smaller. Begley (1996) further suggests that music lessons are reported to help develop spatial skills. Spacial skills are a great topic of interest in this area of research. In the middle of the century, many researchers reported that the relationship of spatial and mathematical skills appeared to be gender-specific. Early factor analyses suggested different structures for males and females (Friedman, 1995). It is also reported that a group of researchers at the Catholic University of America found fewer strong space-math relationships for females than for males. However, a few years later, Friedman (1995) reports that other researchers support the ideas that the space-math relationship might be stronger for girls than for boys. Also in 1995, authors report of a major battle being fought over whether men do in fact, excel in spatial-mathematical ability compared with women. This answer turned out to be that it depends on the type of spatial ability, with mental rotation ability showing strong gender differences favoring men (Casey, Nuttall, Pezaris, & Benbow, 1995).

Mental rotation involves mentally rotating a two-dimensional representation on an object in three-dimensional space. A meta-analysis of the literature was conducted. Both large and consistent average gender differences were reported. A more recent meta-analysis confirmed that this large gender difference has remained stable over the last 17 years ((Casey, Nuttall, Pezaris, & Benbow, 1995). Casey and others (1995) reported that female students in all of the samples showed a significant relationship between mental rotation skills and math aptitude. It is further noted gender differences in both mental rotation ability and math aptitude favors the male gender. Nevertheless, Ramos and Lambating reported in 1996 that this area was the area that

holds the gender gap. They also reported in 1996 that this could be easily rectified with training.

Heredity is an interesting issue. If the parents were exceptional in mathematics, could that have an effect on child's (male and female) mathematical ability? Beckwith (1983) reports that two studies done since the publicity of achievement and genetics in mathematics, which seem to undercut the entire foundation for the hereditarian point of view which have received little or no attention. It is further reported by Beckwith in 1983 that internal factors such as heredity are of no match to the external factors such as society and socio-economic status. In contrast to the socialization explanation, it is reported that heredity differs between the sexes--for example, the inheritance of a particular sex-linked recessive gene--as important determinants of mathematical ability (Aiken, 1987). It is also reported that the biological factors that have been suggested as important in interpreting sex differences in mathematical ability are hormonal differences between the sexes and cerebral lateralization or brain dominance. Beckwith (1983) states that differential brain lateralization between boys and girls required different modes of teaching math for the two sexes. Plateaus in brain development in junior high school students require modifying curricula at this stage. These biological theories have been used to influence many education practices.

Once students enter the school system, many different observations have been noted. Some results of research indicated that there are significant gender, class, and achievement differences in math anxiety of elementary school children (Satake & Amato, 1995). There was a report of inverse relationship between math anxiety and math achievement. It is also reported that females experience significantly greater levels of test anxiety in mathematics than males regardless of grade and/or achievement levels. Using these results, one can generalize or deduce

that since females have a higher test anxiety and test anxiety and achievement are inversely related, females tend to show a lower achievement level in mathematics. Much of the literature in the field of gender differences acknowledges that males perform better than females in mathematics. These differences begin to surface when children enter the middle school years, and then become significant by the time these students enter high school. However, some researchers do not share this view. These researchers argue that the differences have generally disappeared (Ramos & Lambating, 1996).

The decline in the gender differences in the mathematics domain does not hold true for standardized tests such as the SAT. Boys have maintained a higher average in the mathematics scores of the SAT from 1972 through 1993 (Ramos & Lambating, 1996). The results of the study have implications that may assist in interpreting the gender differences that exist on standardized mathematical tests that employ a correction-for-guessing formula. The more omissions made, the lower the score received by the student. Females omitted significantly more items. The results of a study reported by Ramos and Lambating in 1996 may help explain why females perform just as well as males on the mathematics grades they receive in the classroom, but do not perform as well as boys on standardized mathematical tests that employ a correction-for-guessing formula. Females are reported to have omitted more questions when instructions were consistent with those used on standardized mathematical tests which penalize for guessing. Thus, the difference that exists between females and males in their performance on standardized mathematical tests according to Ramos and Lambating (1996) appears to be related to differences in their risk-taking behavior. Males are reported to bigger risk takers; thus, they perform better on multiple-choice standardized exam (Ramos & Lambating, 1996).

Over the past ten years, equity issues in education have received a great deal of attention. Through research in this area, studies have shown that attitudes play a very important role in the learning of mathematics (Steinback & Gwizdala, 1995). Attitudes play a critical role in maintaining a continued interest in mathematics. The Fourth National Assessment of Educational Progress (NAEP) Mathematics Assessment reported that of students surveyed in Grade 11, only one half enjoy mathematics and only 58% say they are good at mathematics. It also state that only 38% plan to take another mathematics course. The results are similar for male and female students in enjoyment of mathematics, but in the area of self-confidence, 58% of the males as compared to 48% of the females say they are good at mathematics (Steinback & Gwizdala, 1996). Society views good performance in mathematics as the exception rather than the rule and expects males to outperform females. The unrestricted power of peer pressure often makes good performance in mathematics socially unacceptable. After two years of research on the inclusion of boys at an all female school, Steinback and Gwizdala (1996) reported that the girls revealed that the boys were considered smarter in mathematics by the teachers. Both sexes were a distraction in the classroom for the other sex. The girls wanted to impress the boys, and the girls felt embarrassed if the performed poorly. After the same study, the boys responded that girls are not as smart so they need more help from the teacher. The girls were a distraction for them, and the teachers considered the boys smarter.

A well-documented gender gap in mathematics achievement has narrowed in the last twenty years (Meece & Jones, 1996). On the basis of this evidence, many educators and researchers believe that the "gender problem" in mathematics has been solved. However, this issue is still quite alive. Many researchers are not quite content with the current status of this

topic.

Some factors that are closely correlated with the existence of the gender gap in the area of the mathematics are: (a) innate differences in mathematics ability between males and females, (b) differential coursework, the number of mathematics course one has taken, (c) the role played by parents, teachers, and peers, and (d) a student's attribution of success and failure in the domain (Ramos & Lambating, 1996). These factors have been taken into deep consideration in order to understand that there are differences and hopefully close the gap and rectify these noted mathematical differences in the genders. Other researchers have listed similar barriers that seem to affect the entry of women into the field of mathematics. These barriers include negative attitudes regarding mathematics and science; lower performance levels than those of White males in mathematics courses and on standardized tests of these subjects; limited exposure to extracurricular mathematics and science activities and failure to participate in advanced mathematics and science courses in high school; and lack of information about and/or interest in mathematics- or science-related careers (Clewell et al., 1992). Once these factors have been eliminated and the causes for the gender gap are identified and eliminated as there should no longer be an issue of the gender gap in the field of mathematics. Because the noted differences in mathematics learning erupts in the middle school and lingers in statistics throughout high school, it is been suggested that society and school play a part in the socialization of mathematics being in the male domain (Skaalvik & Rankin, 1994).

The purpose of this study to determine if there is a gender difference in students' mathematics performance as determined by the Iowa Test of Basic Skills and by the Tests of Achievement and Proficiency in a public school system in rural Southwest Georgia.

## METHODS

This study was conducted in the Randolph County public school system. There are approximately 1,400 students enrolled. Randolph County is located in rural southwest Georgia and has one of the highest poverty rates in the state. Because over 90% of the students qualify for free lunch, the all students who attend are allowed to receive free lunch. Likewise, 80% of the students are reared in single parent homes and receive some assistance from the federal government. The demographic break down of the school reveals that 88% of the student population is African-American; 8% is Caucasian; and 5% is of Hispanic descent.

The information was obtained from the master copy of the students' scores. This roster included each child's gender, grade, and math score as determined by the ITBS test given in Grades 1 through 8 and by its counterpart, the TAP test, given in Grades 9 and 10.

An ANOVA was run on the entire data set to determine if there was a significant difference between the genders on the students' math performance. Then, an ANOVA was performed on each grade to see any more precise differences. An additional ANOVA was run to compare means at each grade level.

## RESULTS

Descriptively speaking, the number of students in Grades 1 through 10 who had taken these tests were 1172 (N=1172). Six hundred one of the students were male constituting approximately 51%, and 571 of the students were female constituting the remaining 49% of the population. The average score for males was 36.2 with a SD of 26.28, and the average score for females was 41.9 with a SD of 27.93. According to the Levene statistic, homogeneity of variance was met (p=.097). An analysis of variance found a significant difference in the total

mathematics achievement scores between genders [$F(1, 1171)=13.222$, $p<.001$] in favor of the female students (see Figure 3). Additional analyses of variance revealed statistically significant differences in mathematics performance favoring females over males in the 1st grade [$F(1, 115)=8.785$, $p<.005$] and in the 4th grade [$F(1, 99)=11.821$, $p<0.002$]. Of the scores reported in the first grade, the average of the males' scores was 48.07 with a SD of 22.99, and the average of the females' scores was 61.72 with a SD of 20.47. Of the scores reported in the fourth grade, the average of the males' scores was 36.91 with a SD of 15.25, and the average of the females' scores was 47.79 with a SD of 17.30. Figure 1 shows the average mean scores for males and for females at each grade level. In all grades, except the second, the girls performed higher than the males.

For further insight, a cross-sectional ANOVA was performed. Figure 2 shows that there is a significant downward trend of math achievement for girls after the first grade ($F=9.025$; $p=.000$). Females' scores in Grade 1 are significantly higher than females' score in all of the other nine grades. Figure 2 also shows that males' mathematical performance changes through grades levels as well.

**CONCLUSION**

This study reveals that there is not a genetic or biological difference in genders to allot for a difference in mathematics achievement or performance. So, any previously reported differences could be learned or could be developed from societal stereotypes. Scott-Hodgetts reports that teacher-pupil relationship and other sociological aspects may affect mathematics performance. Coincidently, there are no males teachers, hence role models, at the school that the first and the fourth graders attend. So, this could very well be an attribute to the outcome of this study. Campbell (1995) reports that in African-American elementary school girls score higher than

African American elementary boys in mathematics. The findings of this study corroborate Campbell's claim.

For the United states to maintain a distinguished position in the world economy, the mathematical skills of its populace must be elevated. A coinciding goal should be bringing into parity in math achievement the fastest-growing segment of the population (one that has traditionally underachieved in the area of mathematics). Women, who make up roughly half of the population, are vastly considered underachievers in the area mathematic.

It is important that research continue on the effects of gender in the learning ability of mathematics. Society must take responsibility to resolve this issue so that the market for high achieving mathematics students will not be exhausted.

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